

Extra AQA Questions on 1.1 Biological Molecules (the answers are at the end of the document)

Q1. Read the following passage.

During the course of a day, we come into contact with many poisonous substances. These include industrial and household chemicals. The skin acts as a barrier and prevents many of these substances entering and harming the body.

- 5 The skin is one of the largest organs in the body. It is composed of several layers of tissue. The outer layer consists of dead cells packed with keratins. Keratins are a group of proteins that differ from each other in their primary structure. Each keratin molecule consists of several polypeptide chains, each individual chain wound into a spiral or helix. The polypeptide chains include many sulphur-containing amino acids and these help to give the keratin molecules their characteristic strength.

Use information from the passage and your own knowledge to answer the questions.

- (a) What is the evidence from the passage that keratin molecules have a quaternary structure?

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(1)

- (b) Explain how sulphur-containing amino acids help to give keratin molecules their characteristic strength (lines 8–9).

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(2)

- (c) Explain why differences in primary structure result in keratins with different properties (line 6).

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(2)

- (d) The skin prevents poisonous substances entering and harming the body (line 3). Explain why these substances are unable to pass through the outer layer of skin cells by active transport.

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(3)

- (e) Skin cells may be studied with a transmission electron microscope or an optical microscope. Explain the advantages and limitations of using a transmission electron microscope to study cells.

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(6)
(Total 14 marks)

Q2. Some enzymes digest protein. They hydrolyse the peptide bonds between amino acids. The extent to which a protein is digested is called the degree of hydrolysis (DH). The DH value may be calculated from the equation:

$$DH = \frac{100 \times \text{Number of peptide bonds hydrolysed}}{\text{Total number of peptide bonds present}}$$

- (a) (i) A protein molecule contains 151 amino acids. What is the total number of peptide bonds in this molecule?

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(1)

- (ii) A molecule of this protein is digested. The DH value of the digested protein is 18. Calculate the number of peptide bonds that have been hydrolysed.

Answer

(1)

- (b) What would be the DH value of a protein if it were completely hydrolysed to amino acids? Explain how you arrived at your answer.

DH value

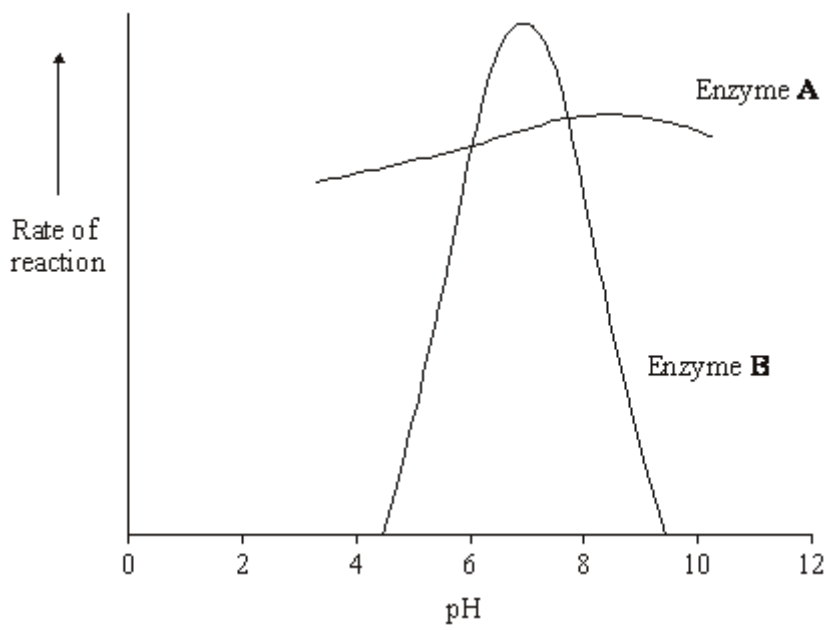
Explanation

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(2)

Enzymes **A** and **B** digest protein. The graph shows the effect of pH on the rates of reaction of these enzymes.



(c) Pepsin is a protein-digesting enzyme found in the stomach. It has an optimum pH of 2 and is fully denatured at pH 6. Sketch a curve on the graph to show the effect of pH on the rate of reaction of pepsin. (1)

(d) Explain why the rate of reaction of enzyme B is low at pH 5.

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(3)

(e) Enzyme A is present in some washing powders used for cleaning clothes. Use the graph to suggest why enzyme A would be of more use in washing clothes than enzyme B. (1)

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(f) Use your knowledge of protein structure to explain why enzymes are specific and may be affected by non-competitive inhibitors. Page 4

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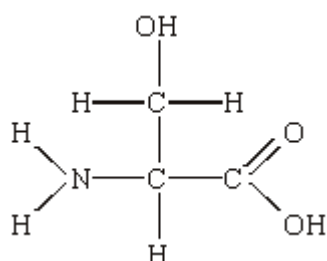
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(6)
(Total 15 marks)

Q3. The diagram shows the structure of the amino acid serine.



- (a) (i) Draw a box on the diagram around the R group of serine and label the box with the letter **R**.

(1)

- (ii) Draw a circle around each of the parts of the serine molecule which would be removed when **two** other amino acid molecules join directly to it.

(1)

- (b) (i) Which **two** substances are formed when two amino acid molecules join together?

1

2

(1)

- (ii) Name the type of bond formed between the joined pair of amino acid molecules.

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(1)

- (c) Explain how a change in the primary structure of a globular protein may result in a different three-dimensional structure.

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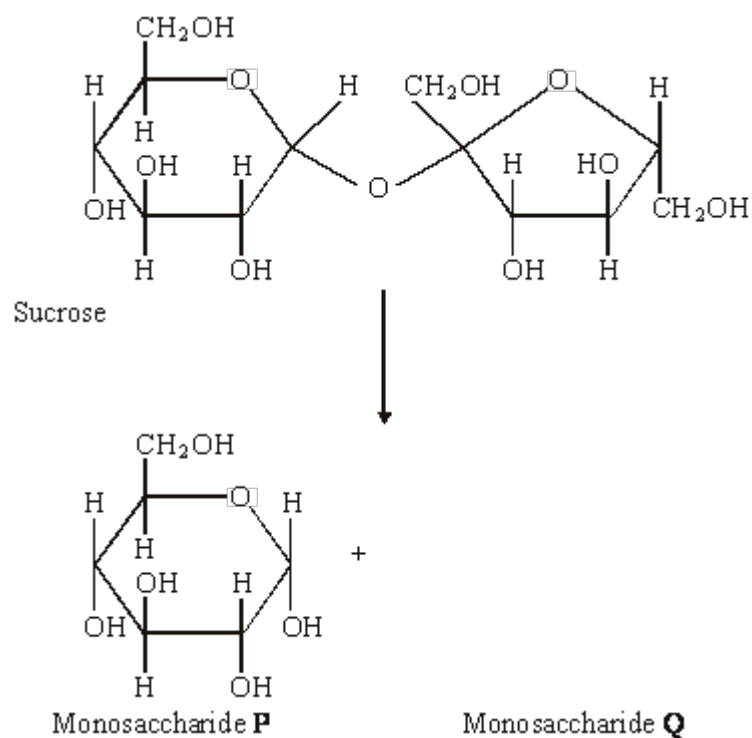
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(3)

(Total 7 marks)

Q4. Sucrose is a disaccharide. It is formed from two monosaccharides **P** and **Q**. The diagram shows the structure of molecules of sucrose and monosaccharide **P**.



- (a) (i) Name monosaccharide **Q**.

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(1)

- (ii) Draw the structure of a molecule of monosaccharide **Q** in the space above.

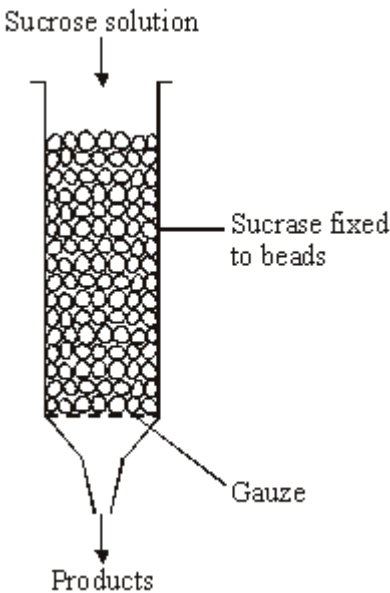
(1)

- (b) The enzyme sucrase catalyses the breakdown of sucrose into monosaccharides. What type of reaction is this breakdown?

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(1)

- (c) The diagram shows apparatus used in breaking down sucrose. The enzyme sucrase is fixed to inert beads. Sucrose solution is then passed through the column.



Describe a biochemical test to find out if the solution collected from the apparatus contains

(i) the products;

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(2)

(ii) the enzyme.

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(2)
(Total 7 marks)

Q5. (a) **Figure 1** shows the structure of a molecule of glycerol and a molecule of fatty acid.

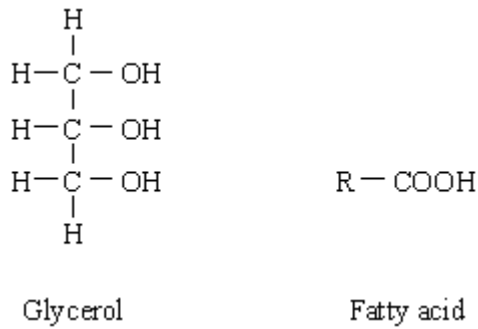


Figure 1

Draw a diagram to show the structure of a triglyceride molecule.

(2)

(b) Explain why triglycerides are **not** considered to be polymers.

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(1)

(c) **Figure 2** shows two types of fat storage cell. Mammals living in cold conditions have more brown fat cells than mammals living in tropical conditions.

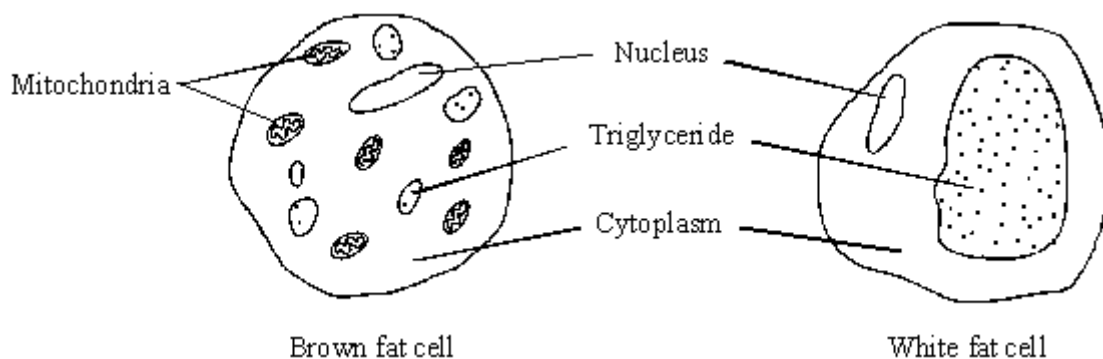


Figure 2

Using evidence from **Figure 2** to support your answer, suggest how the function of brown fat cells differs from that of white fat cells.

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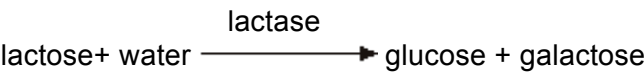
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(3)
(Total 6 marks)

Q6. Lactose is a disaccharide sugar which can be broken down by the enzyme lactase into two monosaccharides, glucose and galactose.



(a) The formula for galactose is C₆H₁₂O₆. What is the formula for lactose?

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(2)

(b) A solution containing the enzyme lactase was added to a lactose solution. The solution was incubated at 40 °C for one hour. Sample **A** was removed from the tube before incubation. Sample **B** was removed after one hour.

(i) Describe a chemical test you could carry out on sample **A** to show that lactose is a reducing sugar.

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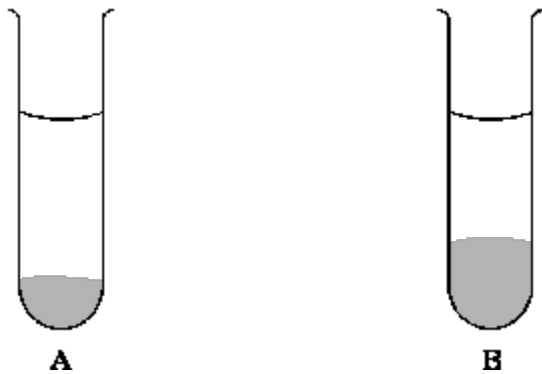
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(2)

(ii) This chemical test was carried out on samples **A** and **B**. All experimental variables were the same in the testing of the two samples. Both tubes were left for ten minutes to allow the precipitate to settle. The diagram shows the result.



Is galactose a reducing sugar?

Explain how the results in the diagram support your answer.

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(2)
(Total 6 marks)

M1. (a) Several/more than one polypeptide chain in molecule;

Evidence must only relate to 4° structure

1

(b) Chemical bonds formed between sulphur-containing groups/
R-groups/form disulphide bonds; Stronger bonds; Bind chain(s)
to each other;

max 2

(c) Different number of amino acids; Different sequence of amino
acids; Bonds in different places; Gives different shape;

max 2

(d) Outer layer of skin cells are dead; Do not respire/Do not contain
mitochondria; Do not produce ATP/release energy; Cells do not
have required proteins/carriers;

max 3

(e) 1 TEM uses (beam of) electrons;

2 These have short wavelength;

3 Allow high resolution/greater resolution/Allow more detail to
be seen/greater useful magnification;

4 Electrons scattered (by molecules in air);

5 Vacuum established;

6 Cannot examine living cells;

7 Lots of preparation/procedures used in preparing specimens
/ fixing/staining/sectioning;

8 May alter appearance/result in artefacts;

max 6

[14]

M2. (a) (i) 150;

1

(ii) 27;

1

(b) 100;
number of peptide bond hydrolysed = $\frac{\text{Page 12 total number present}}{\text{all peptide}}$

bonds have been hydrolysed;
accept calculation showing same number top and bottom.

2

- (c) curve rising to peak at pH 2 and falling to zero by pH 6;

1

- (d) (change in pH) leads to breaking of bonds holding tertiary structure
 / changes charge on amino acids;
 enzyme/protein/active site loses shape/denatured;
 substrate will not bind with/fit active site;
 fewer/no ES complexes formed;

3 max

- (e) more resistant to changes in pH and washing conditions variable/
 works in alkaline pH and washing powders alkaline;
*mark awarded for indicating aspect of effect of pH and advantage of this
 in terms of washing powder and conditions in wash.*

1

- (f) *maximum of three marks for specificity, points 1 - 4.
 Can only be given credit in context of specificity*

- 1 each enzyme/protein has specific primary structure / amino acid sequence;
- 2 folds in a particular way/ has particular tertiary structure;
- 3 active site with unique structure;
- 4 shape of active site complementary to/ will only fit that of substrate;
maximum of three marks for inhibition, points 5 – 8
- 5 inhibitor fits at site on the enzyme other than active site;
- 6 determined by shape;
- 7 distorts active site;
- 8 so substrate will no longer fit / form enzyme-substrate complex;

6 max

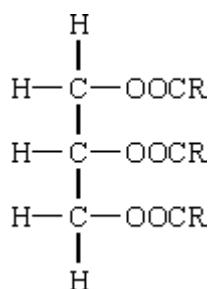
[15]

(allow circle if labelled R);

		1	
	(ii) circle drawn around either of the Hs on NH ₂ group and circle drawn around the OH;	1	
(b)	(i) (di)peptide and water;	1	
	(ii) peptide;	1	
(c)	sequence of amino acids changes; tertiary structure changes/folds in a different way; bonds form in different places; (Reject peptide bonds)	3	[7]
M4.	(a) (i) fructose;	1	
	(ii) correctly drawn (OH group at bottom left);	1	
(b)	hydrolysis;	1	
(c)	(i) <u>heat</u> with Benedict's solution (<i>disqualify if HCl added</i>); orange/brown/brick red/green/yellow colour or precipitate;	2	
	(ii) biuret test / NaOH + CuSO ₄ ; purple / violet / lilac / mauve;	2	[7]

- M5.** (a) 3 fatty acids attached;
ester bond correct;

(*H on glycerol component, O attached to carbon, R at other end*)



2

- (b) not made of monomers/many repeating units;

1

- (c) (many) mitochondria present in brown fat cells;
mitochondria release heat/energy; (*ignore ATP*)
white fat cells for fat storage / reduced fat storage in brown fat cells;

3

[6]

- M6.** (a) C_{12} ; $\text{H}_{22}\text{O}_{11}$;

2

- (b) (i) heat with Benedict's;
yellow/brown/orange/red;

2

- (ii) (yes)

(*may appear on second line*)

more precipitate in sample **B**;
both sugars are reducing sugars/ give a positive test;

2

[6]